IMPACTS OF OFFSHORE WIND FARMS ON MARINE BIOTA: CHANGES IN BENTHIC AND FISH COMMUNITIES AT NORTHERN EUROPE, ARE THEY COMPARABLE TO MEDITERRANEAN ECOSYSTEMS?

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Abstract
Deployments of Offshore Wind Farms (OWF) are increasing throughout northern European seas. Few studies are dealing on impacts on marine biota. Revision of OWF monitoring on marine organisms reveals impacts as a result of substrate addition, indicating similar effects to those provided by artificial reefs and fish aggregation devices. Responses from ongoing projects at northern Europe will be discussed for expectation of further developments of OWF at the Mediterranean.

Keywords: Fishes, North-Western Mediterranean, Zoobenthos, Coastal management

Introduction
Marine renewable are increasing throughout northern European [1]. Effects of offshore wind farms on marine biota are diverse including addition of new substrate, creation of electromagnetic fields, noise, vibrations… [2]. Few studies have addressed such impacts. We hypothesized that OWF substrate addition is changing marine community structure; therefore we focus on discerning benthic and fish communities' changes to new substrate addition after OWF deployment. The expectation is that this data can serve as a baseline for establishing trends at Mediterranean ecosystems.

Material and methods
Review and analysis of 9 technical documents and scientific papers including biological data on OWF farms have been performed. OWF from Denmark, Holland, Belgium and England have been considered including temporal variation from 2001 to 2012. Two types of data have been addressed separately: benthic assemblages and fish communities. Permutational analysis of variance on log (x+1) transformed abundance data has been calculated at datasets from OWF, control areas, seasons and years.

Results and discussion

Benthic communities based on 17 taxonomic groups highlighted a dominance of Bivalvia and Nermertina at the OWF areas and a dominance of Amphipoda, Phoronida, Polychaeta at control areas. Benthic invertebrates are significatively differing among OWFs (Permanova, p>0,001). The sampling methodology is also modifying the observed benthic assemblages. Moreover, seasonality is influencing the faunal communities. (Table 1):

Tab. 1. Permanova for invertebrate species at OWF (Offshore Wind Farms) based on Bray-Curtis similarities. Fixed factors: Treatment: impact:OWF-control. Survey (sampling methodology: box-corer, trawl, triple-D dredge). Year (2005, 2007, 2008). Season (spring, autumn) . CV (Coefficient Variation) p<0,001

Source of variation	df	SS	MS	Ps-F	P(perm)	CV
OWF	2	67387	33694	49,78	0,001	27,97
Treatment(OWF)	3	1610,8	536,93	0,79	0,659	-2,40
Survey(OWF)	1	1,18E+05	1,18E+05	174,92	0,001	54,15
Year(Tr(OWF))	2	697,85	348,93	0,51	0,848	-5,51
Tr(OWF)xSu(OWF)	1	526,46	526,46	0,77	0,554	-2,73
Season(Ye(Tr(OWF)))	6	12063	2010,5	2,97	0,001	15,57
Res	195					26,01
Total	210					

Biomass increase in benthic communities can be highly relevant, although little is know about large-scale OWF consequences on marine biota (3). Temporal surveys determined an increase in organic matter, while abundance, species richness and invertebrate biomass was following a similar pattern at both OWF and control areas (4).

Tab. 2. Permanova for fish species at OWF (Offshore Wind Farms) based on Bray-Curtis similarities of log(x+1)-transformed data. Fixed factors: Treatment: impact:OWF- control. Year. Season (spring, autumn) . CV (Coefficient Variation) p<0,05

Source of variation	Df	SS	MS	Ps-F	P(perm)	CV
OWF	3	1,4E+05	48900	84,92	0,001	42,29
Tr(OWF)	4	3802,4	950,59	1,65	0,048	5,18
Ye(Tr(OWF))	3	9322,6	3107,5	5,39	0,001	16,96
Se(Ye(Tr(OWF)))	6	21141	3523,5	6,11	0,001	23,15
Res	97	55859	575,87			23,99
Total	113	2,4E+05				

Fish species
Several taxonomic groups from 5 OWF studies were quantified. The results highlight differences among offshore wind farms faunal assemblages. Fish species respond more clearly to OWF deployment exhibiting also temporal differences Permanova (Table 2):

Species mobility might explain the observed patterns linked to life cycle of each species. Seasonal variations are tight to environmental variability driving species responses. Time since deployment is also relevant for the observed communities around OWF. Previous studies on demersal assemblages showed a biomass increase of fishes surrounding the wind turbines (5). Future developments at Mediterranean coasts should include those aspects of variability within marine biota responses.

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